THE BUZZER

and Other Devices for Induction Telegraphy

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The Buzzer, and Other Devices for Induction Telegraphy*

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The military telegraph has now become so firmly established as part of the necessary equipment of an army in the field that no modern military operations could be undertaken without the provision of such apparatus. In its familiar forms of relay, key and sounder, the operators of the last fifty years have grown to regard this combination as indispensable for telegraphy, in connection with huge bluestone-batteries, or, later, the storage battery installation or dynamos of terminal stations.

In no branch of electrical industry has development been more conservative. With few improvements in office apparatus and none in the principle of operation, the army of American telegraphers has grown to regard the art of telegraphy as comprised in the apparatus named. They accordingly resent the intrusion of novel methods and the introduction of strange apparatus. With a skill unequaled in the world for transmission and reception of messages by sound, they regard the displacement of their familiar 150 ohm relay, key, and sounder as an affront and a reproach on their efficiency.

When the military operator attempts to apply his familiar apparatus to the lines with which he has to deal, great difficulties at once appear. Transportation on the field is beset with uncertainties and is sternly limited by the necessities of many others. The military operator is at once asked to use lighter wire than on his standard lines, and increased resistance is the first result. His strong lines of

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poles and excellent, well insulated aerial wires soon disappear in poor construction, and he must at best put up with the hasty lance lines and wires lying against untrimmed foliage that make his insulation a rapidly disappearing quantity, especially in damp weather. His batteries at headquarters grow apace, until in despair he sends his cells afield along his lines to establish strengthening batteries at various points. Soon reports come back of abandoned or broken down wagons, smashed cells, and dissolved bluestone, and reserve battery power disappears even before it is installed.

On these military lines, even in dry weather, adjustment to get stations over poor wires is hard enough, but with dew and rain, such troubles become formidable, and with much anxious labor, skill, and imagination, fragmentary messages, backed by frantic demands of the staff, may be worked through with difficulty.

When the military telegrapher is called on to follow movements in swift strategical marches, or to connect up points of prime importance in tactical movements, where even in battle it is demanded that lines of information be maintained at any cost, he finds his old reliable means to be entirely inadequate, and the handicap is so severe that in many cases in the past military operations have been seriously hampered by failure of these lines at crucial periods.

The so-called flying telegraph trains of Civil War times were cumbrous affairs. The inappropriateness of the title seems evident with the long trains of lance trucks, wire wagons, battery wagons and equipment wagons.

Some means for operating our high resistance and poorly insulated lines had to be devised, and the incubus of bulky, fragile, and unreliable batteries done away with. The most urgent need for such

improved service was felt in the new tactical lines which modern war had called into existence. In these last, of course, light and reliable wire which could be rapidly laid and operated on the ground was part of the necessary improvement.

In 1881 we find the first really successful attempt to break away from old methods of telegraphy for military uses. Major Cardew, R. E. of England, proposed the use of a coil in which the current is controlled by an interrupter as a transmitter, and a telephone receiver as a detector of the rapidly intermittent induced current. Thus was our now familiar buzzer brought into existence. It was experimented with for some years, until in 1884 it was successfully used by the telegraph engineers in maintaining communication in the expedition to Khartoum, over lines impossible for Morse working. Just why its development as a valuable military telegraph device apparrently went no further in England is not known. It is significant, however, that this country, having a Signal Corps which is especially charged with this class of work, should have perceived the advantages of such devices, and proceeded with their development to a point unknown elsewhere. In fact, our development of them has been extensively copied in foreign armies, England itself again reviving its interest in them. Thanks for their introduction and early development are due to the present Chief Signal Officer, General James Allen.

Our types of buzzers differ somewhat in appearance, size and mode of operation, but they eacch have this in common: A few dry batteries, an interrupter and a coil, with the circuit controlled by a key, are in a strong leather-covered case. With these are included a telephone transmitter and receiver. The operation of the key actuates the buzzer, and its impulses go out over the line as dots or dashes, depend-

ing on the time the key is depressed. The telephone receiver responds to these electrical impulses giving the humming or buzzing sound from which the instrument derives its name.

The buzzer owes its usefulness to three things:

First.—We are able with a few dry cells to operate an interrupter and coil which transforms the interrupted primary current driven by the few volts of the cells into a smaller current driven by a much greater alternating voltage of a frequency that gives a high note in the telephone receiver.

In substituting the few dry cells and step-up transformer for the wet batteries of the Morse lines, we have gained enormously in weight, bulk, portability and certainty of operation.

Second.—The buzzer's utility depends equally upon the delicacy of the instrument at the receiving end. The telephone receiver is an instrument of marvelous sensitiveness to currents of higher acoustic frequencies. Houston & Kennelly are authority for the statement that an alternating current of forty-four billionths of an ampere may produce an audible sound, and that an ordinary telephone receiver falling from a height of one foot could develop sufficient electrical energy to produce a continuous sound in it for 240,000 years.

Third.—The buzzer requires no adjustment at the receiving end. Leaks, bad connections, high resistances, either of which would cause loss of some or all of the signals on Morse instruments, simply affect the loudness of the signals in the telephone receiver.

Fourth.—From its construction and mode of operation we may substitute a telephone transmitter for the key, and produce variations in the resistance by the voice instead of interruptions by the vibrator and key, thus instantly converting the telegraph into

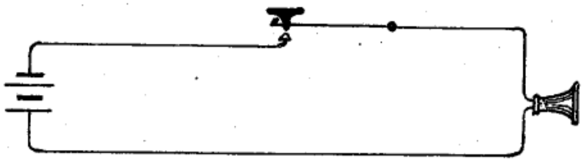
Fig. 1

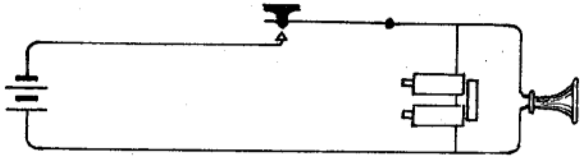
Fig. 2

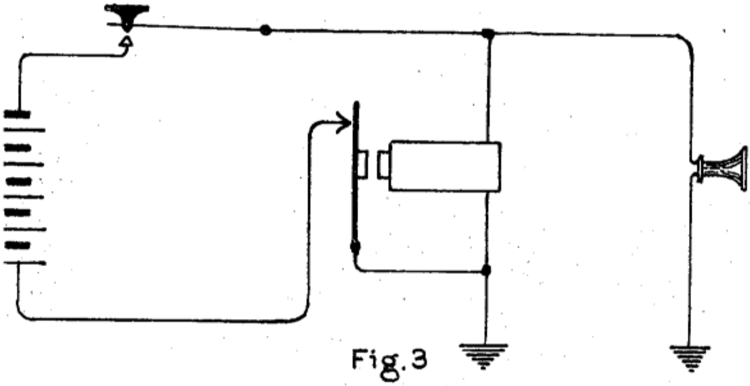
Fig. 3

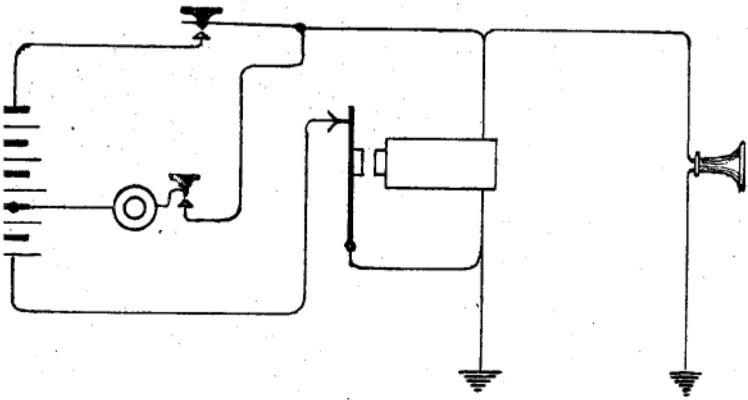
Fig. 4

telephone stations. This feature alone is of great importance, especially on instruments for operating tactical lines.

The delicacy of the telephone receiver makes telegraphy possible over lines long after Morse operation has ceased. On short lines with good insulation the sound is loud enough to be heard for several feet or more. As the resistance of the line rises or the insulation decreases, or both, the sound becomes fainter, but operation remains possible, even with very weak sounds. Instances have been known when the buzzer has been operated over thirty miles of wire, most of it bare and laid on the ground in rainy weather. Other instances have been known of its working over a broken wire where the two ends were on wet ground at distances of from a few feet to forty feet apart.

Two types of buzzers have been adopted for our field service—the field buzzer and the cavalry buzzer. The general principle of operation is the same. In the field buzzer a single coil is employed which, with battery and key, operates the interrupter directly. The two terminals of this coil are connected with the ground and line respectively. At make or break, the voltage at these terminals is greatly enhanced by the action of inductance, and alternating currents flow over the line and through the distant telephone receiver.

The action of the coil is shown in the following experiments: A telephone receiver, key, and two dry cells are connected in series. When the key is operated crackling sounds are produced in the receiver at make and break (Fig. 1).

Connect an electromagnet (say a four ohm sounder) as shown in Figure 2.

The sound will be much louder now than before, especially at break. This is due to the relatively high

electromotive force produced at the terminals of the electromagnet when the battery circuit is broken, by the sudden disappearance of the lines of force of the electromagnet. If now we introduce an interrupter in the circuit, extend the upper wire to the receiver at the distant station and let the ground act as the lower wire, we shall have the simplified buzzer circuit (Fig. 3).

If now we introduce a transmitter and switch in parallel with the key and utilize only enough of the cells to operate the transmitter properly, we shall have the complete connections of the field buzzer so far as operativeness is concerned.

Shunting the interrupter it is advantageous to place a condenser of about .25 mf in series with a resistance of about 25 ohms to prevent sparking and make the tone of the buzzer clearer. The newest type of field buzzer weighs nine pounds with batteries complete.

The cavalry buzzer which was introduced in our service a few years ago employs practically all the parts of the field buzzer with the exception that it utilizes a small induction coil, about the same as a local battery telephone, in place of the single-wound coil, and has a small separate interrupter in series with the primary of the induction coil.

The simplified diagram of its circuits are shown in Fig. 5.

Two small dry cells in one case furnish the current, and these automatically connect with the circuit by means of spring contacts. When the key A_2B_2 is depressed the current runs through the primary of the induction coil P and then through the contact E and small electromagnet of the interrupter. A small condenser C_2 shunts the interrupter break. Thus there are produced rapidly-alternating currents of comparatively high voltage in the secondary S which go out on

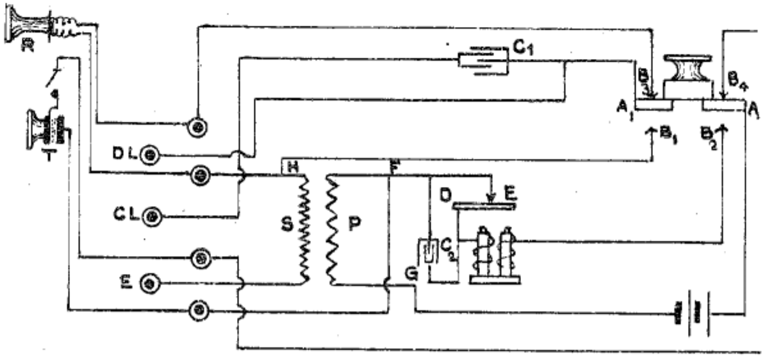

Fig. 5

Induction Field - Telegraph

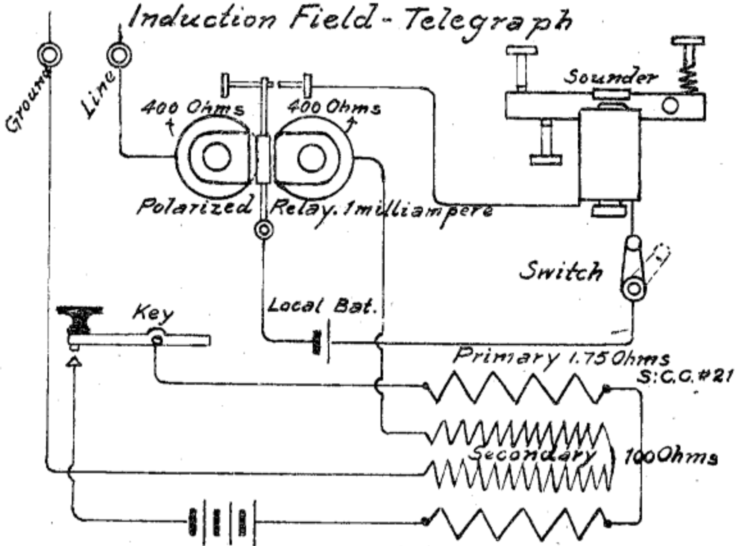

Fig. 6

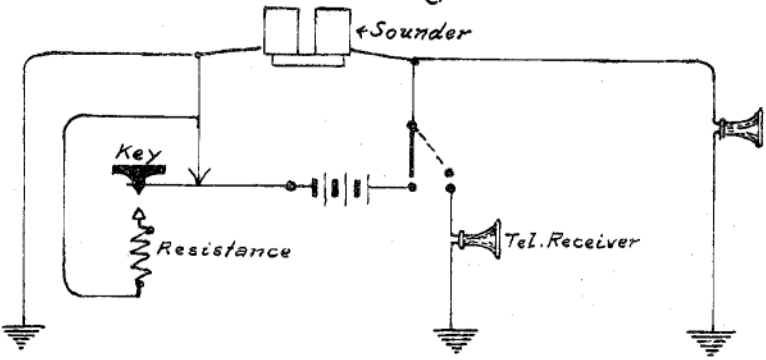

Fig. 7

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the line through D L and to the distant telephone receiver. There is a second key A_1B_1 so arranged that when the current-controlling key is depressed the second key puts the secondary coil to line cutting out the home telephone receiver, and thus prevents loud buzzing in the operator's ears from his own instrument.

A condenser C_1 is provided in an alternative path to line through C L which permits of attaching a buzzer directly to a telegraph line. The condenser freely permits passage of the voice or buzzer currents but blocks those of the telegraph, thus not interfering with its operation.

This buzzer is provided with a transmitter T in the same way as the field buzzer, and by depressing the talking switch the set is converted into a local battery telephone.

The cavalry telephone weighs about seven pounds, and is not much bulkier or heavier than a good sized field glass. Its great utility is in cutting in quickly on field lines on temporary field stations by means of a test clip. It is a matter of a few seconds only for a mounted man to dismount and open communications with any station on the line; and he may as quickly disconnect and proceed.

When camp lines are established or field lines connect headquarters with busy offices in the field, the continual use of the buzzer will become very irksome to operators. In such cases the substitution of the sounder is a great relief and materially expedites business. At the same time the lines are frequenly temporary ones of high resistance and poor insulation, and wet batteries of the bluestone or similar types are usually not available when wanted. To meet this need the field induction telegraph set has been devised. Here again the induction coil is called into use to step up voltage, but at the receiving end a

polarized relay is used in connection with a sounder.

The entire set is contained in a strong case, and consists essentially of a polarized relay, 6-ohm sounder, a double core induction coil of peculiar pattern, four dry cells (No. 5), and a key.

The operation is as follows, (Fig. 6). When the key is depressed the circuit of three of the dry cells is closed through the primary of the induction coil. This produces a momentary induced current which passes through the secondary of the coil, relay of home station, line, relay of distant station, secondary of coil and to ground.

The relays are set so their tongues lie on either side when no current runs. When the induced current described passes, they are both sent to the front contact by the impulse and remain there until the key is lifted, when the induced current in the other direction throws them against the back stop.

The sounders are operated by the fourth dry cell of each set. The relays used are very sensitive, less than one milliampere being required for their operation.

In tests these sets have been operated through 40,000 ohms dead resistance, and they have been operated through very leaky lines that are impracticable for ordinary Morse operation.

The sets weigh about fifteen pounds complete, and so are lighter and less bulky than a field telephone. A lighter pattern which substitutes a polarized main line sounder for the relay may prove sufficiently sensitive, and it is simpler, lighter and more compact.

Another method of induction telegraphy, which has been used commercially to a considerable extent, is known as the *phonoplex*. In this a battery, and a coil larger but similar to those of the field buzzer, are the sources of the induced current impulses. No

interrupter is used, however, but a single impulse is given when the key is depressed, and another, but weaker, when the key is raised. These go over the line and pass through a telephone receiver. When the key is depressed the receiver gives a loud snap—when the key is raised the weaker current through the resistance makes another snap, somewhat softer. The result is that the sounds in the telephone receiver resembles upward and downward clicks of the Morse sounder.

In a simplified form this system is very applicable to military field telegraphy, and it will work over bad lines almost as well as a buzzer in some instances. At the same time it has the advantages of ordinary Morse receiving.

In Fig. 7 is represented a simple phonoplex circuit which may be extemporized with apparatus usually at hand, and which will operate over leaky or high resistance lines when buzzers or field induction telegraph sets are not available. In this the sounder magnet is used simply as an inductance coil, the discharges from which go over the line and give the sounds in the telephone receiver, corresponding to up and down strokes. The key has front and back contacts, and the switch controls the battery and receiving telephone circuits. A resistance of from 3 to 5 ohms is inserted in the front contact of the key.